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DEVELOPMENT AND PERFORMANCE EVALUATION OF MULTI CROP THRESHER

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ABSTRACT

Commonly available threshers are primarily designed to thresh cereals and pulse crops. Increasing production of oilseeds in India has necessitated evaluating these threshers for threshing oilseeds, particularly safflower (*Carthamus tinctorius Linn*) because of its important in diet, industries, agriculture and medicines. Traditional manual methods of threshing safflower is uneconomical and consume more labour, hence there is an need to reduce the drudgery and to improve the quality of threshed seeds by providing an appropriate machine to the farmers to meet their needs. A commercial model thresher of multi crop potential was designed. The machine was evaluated for safflower at two levels of moisture (10.89% and 12.05%), three levels of cylinder speeds (840rpm, 735rpm and 630rpm) and three levels of feed rates (240kg/hr and 180kg/hr) keeping the concave clearance (3.2cm) constant. A threshing efficiency of more than 98% and grain output of 28.84 – 72.48kg/hr were obtained. The grain damage, unthreshed grain proportion, cleaning efficiencies and total grain loss varied from 0 to 0.973%, 0.62% to 1.953%, 92.797% to 99.74% and 5.513 to 20.82% respectively.

KEYWORDS: Thresher Model, Multi Crop, Threshing Efficiency and Grain Loss

INTRODUCTION

Indian agriculture witnessed technological break-through in the mid-sixties. The release of high yielding varieties (HYV's), new package of practices for realising their potential, mechanisation of agriculture by introduction of machinery for irrigation, tillage, harvesting, threshing etc. are regarded as technological innovations in agriculture. The divisible nature of seed fertilizer technology allows the benefits of technological progress to spread amongst the small peasant holdings, which constitutes the core of agriculture sector in the developing countries.

The past year has been very conducive for an all-round growth of agriculture. As per recent Economic Survey 2010-11 released by the Government of India, agriculture sector registered a growth rate of 504% which resulted in an overall share of 14.25 in the real GDP during the year. The growth of food grains, oilseeds, cotton, sugarcane, fruits and vegetables were 6.5, 11.9, 41.2, 15.2, 4.1 and 3.85 respectively. Agricultural production has increased significantly in last 20 years even as the country's booming population outpaces it. One of the biggest challenge before the agricultural sector of India is to meet the growing demand for food grains for feed the increasing population. This will require both higher energy inputs and better management of food production systems. Therefore there is at present a need for using other inputs for enhancing the production. One of the vital inputs is farm mechanization for timeliness of farm operations and reducing post-harvest losses.

MATERIALS AND METHODS

The thresher designed and developed for performance evaluation consist of a continuous feeding chute, threshing cylinder, concave, single oscillation eccentric assembly, blower, aspirator, power transmission system, main frame and transportation wheels.

The constructional details and testing procedures followed for testing the performance of the thresher are discussed under the following section.

Description of the Multi-Crop Thresher

The power operated multi crop thresher is a thrown in type thresher with the functional component likeTricycle frame, Feeding chute, Threshing cylinder, Concave grate, Threshing drum, Cleaning and separating unit, blower, power transmission and fly wheel.

Tricycle Frame

The tricycle frame has been purchased from the local market and necessary flat farm was fabricated using 25 mm and 40 mm angle iron. The provision has been provided to fix all other units of the thresher. The wheels were provided a provision to get drive from pedal whenever necessary.

Feeding Chute

The feeding chute is provided at the top side of the threshing drum at left side. The width of the chute is 280 mm and length is 400 mm, has opening of 360 mm x 200 mm at throat (rear end) and 600 mm x 600 mm at front end (feeding end), and 820 mm length made with 18 gauge G.I. sheet. The feeding chute was fixed to the casing at 1350 mm height from the ground level by means of M.S bolts and nuts and has an inward inclination of 45^0. A feed roller of 200 mm diameter fixed on a 20 mm diameter shaft had a clearance of 75 mm with bottom plate. Two mm thick and 25 mm width M.S plates (6 No.) were welded parallel to the axis at equal spacing. This feeding arrangement enables easy and continuous feeding of crops like safflower.

Threshing Cylinder

The threshing cylinder was made up of MS pipe of diameter 144 mm and length 248 mm. The cylinder was provided with 48 no of pegs in 8 lines and in helical farm. Two pedestal bearings were provided of 25 mm were provided for easy movement of the threshing cylinder.

Concave

A mesh type of 75 mm MS bars and bent into an arc of a circle of 230 mm was fixed below the threshing drum, and concave was made square rods of 4 mm size and it was provided below the threshing cylinder. The concave clearance can be adjusted as per crop requirement. It can also be removed and checked for its proper working.

Threshing Drum

The threshing drum was made up o MS sheet of gauge 14 and it was fully covered over threshing cylinder. I can be easily removed and any adjustments of threshing cylinders can be done.

Sieve with Oscillating Eccentric Assembly

A long rectangular sieve of 460 x 585 mm with 8.8 mm punched holes at 7.5 mm spacing along the length was hung on the sieve holder. An eccentric assembly was fixed to rear side of the sieve to provide oscillations. The system consisted of an eccentric, eccentric shaft, frictional bearing, ball bearing and a connecting rod.

The system received power from power transmission system and gets actuated to oscillate to and fro with amplitude of 12 mm. The sieve provided makes and angle of 3^0 and 2.2^0 to horizontal at the end of forward and backward strokes respectively.

Blower

The blower is made up of MS sheet having a gauge 16. It has got four wings at right angles to each other enclosed in a casing and is fitted between the screen and grain pan to produce sufficient air stream to blow off the chaff and dust screened through the sieve.

Grain Pan

A grain pan made of 18 gauge MS sheet was fixed along the sieves to oscillating assembly. An integrated grain outlet was provided its lower end at ta height of 300 mm above ground level to collect the grain.

Aspirator

The aspirator consist of 277.75 mmx 135 mm MS sheet paddles (4 No.). Rods of length 47.5 mm supported the blades and were fixed over a hub. The fixed on the main threshing drum shaft. The aspirator unit was completely enclosed in causing with inlet open to sieve / baffle and outlet open outward.

Power Transmission

First pedal power was transferred to the central axis of size 20 mm through chain and sprocket. From central axis to intermediate axis to double rpm, then from intermediate axis transferred to flywheel of size 330 mm. On the axis of the flywheel threshing drum of diameter 200 mm was fixed with 48 No. of pegs. From other end of the flywheel axis drive was taken to eccentric assembly for cleaning unit. Blower was provided drive from central axis.

Prime Mover

A five horse power induction motor (50Hz, 415 V, 1420 rpm) was used as the drive source. The motor was at the sieve end over the main frame, using two rails made of MS plates were fitted with the help of nuts and bolts. A suitable star-delta starter was used in the circuit for starting and stopping the motor.

Table 1: Specifications of Developed Pedal Operated Thresher

Sl. No.	Particulars	Specifications
1	Type of machine	Pedal operated thresher
2	Overall dimensions (mm)	
	Length	2520
	Width	1180
	Height	1600
3	Weight, (kg)	145
4	Power source	Manual
5	Threshing cylinder dimensions (mm)	
	Diameter of the drum	410

Table 1: Contd.,		
	Length of the drum	240
	Length of peg	50
	Diameter of peg	10
	Average rpm of drum	450
	No. of pegs in row & no. of rows	8 & 6
6	Width of concave (mm)	310
7	Length of concave (mm)	300
8	Concave clearance (mm)	10-12
9	Length and breadth of cleaning units, mm	600 x 300
10	Average rpm of blower	280

Plate 1: Developed Multi Crop Thresher

Procedure for Testing the Pedal Operated Multi Crop Thresher

The developed pedal operated multi crop thresher was evaluated for threshing of jowar and bajara which were grown in Main Research Station (MRS), Raichur.

The testing was carried according to the RNAM test codes (Regional Network for Agricultural Machinery Test code and procedure for power Grain thresher; part 12). The parameters selected for performance evaluation were, two types cylinders namely rasp bar type and peg tooth type. Each combination type of threshing cylinders namely rasps bar type and peg tooth type. Each combination type of threshing cylinder and speed were replicated thrice.

The speed of the threshing drum was measured using hand held tachometer. The required feed rates were (240 kg/h, 210 kg/h, 180 kg/h) obtained by feeding crop samples of 20 kg, 15 kg and 15 kg in 5 min, 4 min, 4.3 minutes respectively. The concave clearance was kept constant (3.2 cm) throughout the test. Four labourers worked throughout the test for feeding crop supply, bundling samples, etc., one labour was used to run the thresher.

During the test run, samples were collected at regular intervals (1/2 minute) for unit time (1 min) at the main grain outlet, chaffed at raw outlet, chaff outlet and speed of the threshing drum shaft (rpm) and wattmeter readings were recorded thrice simultaneously. At the end of each feed rate the thresher was run idle for some time.

The weights of the samples whole, damaged grain, un threshed grain and foreign material for the samples collected at main grain outlet, chaff outlet were noted to determine the parameters total grain input, percentage damage garn at all outlets, percentage of grain loss, percentage of un-threshed grains, threshing efficiency, cleaning efficiency, threshing recovery and output capacity

Determination of Performance Parameters

From the analysis of samples and sampling time, feed rate, threshing recovery, threshing efficiency, cleaning efficiency of main grain, outlet rate of damaged grains, loss of grain were calculated as follows.

- **Total Grain Input (A) = B+C+D**

  Where A = Total grain input per unit time by weight..

  B = Weight of threshed grain (whole and damaged) per unit time

  C = Weight of threshed grain (whole and damaged) per unit time collected at all except outlets for main grain outlet.

  D = Weight of un-threshed grain from at all outlets per unit time.

- **Percentage of damaged grains at all outlets (PODG):**

  PODG = $\frac{E}{A}\times 100$ **%**

  E = Quality of damaged grain collected at all outlets per unit time.

- **Percentage of grain loss (POGL):**

  PODG = $\frac{G}{A}\times 100$ **%**

  G = Weight of whole grain, damaged grain and un threshed grain per unit time at chaff outlet and chafed straw outlet and scattered grain pet unit time.

- Percentage of un-threshed grain (POUTG) :

  POUTG = $\frac{H}{A}\times 100$ **%**

  H = Weight of un-threshed grain per unit time at all outlets.

- Threshing efficiency = 100 – Percentage of un-threshed grain.

- Cleaning efficiency CE = $\frac{I}{J}\times 100$ **%**

  I = Weight of whole grain per unit at the main grain outlet.

  J = Weight of whole material per unit time at the main oulet.

H = Threshing recovery.

Treatments

T_1: Crop Jowar; T_2: Crop Bajra

C_1: Rasp bar type cylinder; C_2: Peg tooth type cylinder

S_1: Cylinder speed 300 rpm; S_2: Cylinder speed 400 rpm; S_3: Cylinder speed 500 rpm

RESULTS AND DISCUSSIONS

The pedal operated multi crop thresher was tested for jowar and bajra and various performance parameters were studied with respect to independent parameters like type of cylinders and different cylinder speeds. The parameters of performance that were studied are presented under the following tables.

Table 2: Performance of Thresher with Rasp Bar Type Cylinder for Jowar Crop

Treatment	Grain Output (kg/h)	Threshing Efficiency %	Grain Damage %	Cleaning Efficiency %
$T_1C_1S_1$	75.311	87.21	1.90	86.34
$T_1C_1S_2$	77.501	88.51	1.99	86.43
$T_1C_1S_3$	78.301	89.13	2.13	87.14

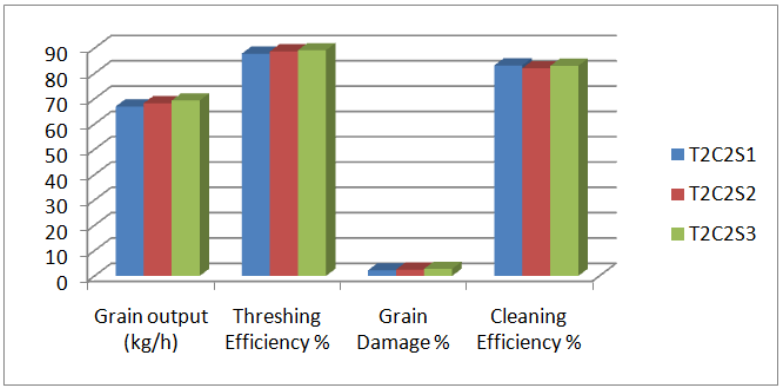

Figure 1: Performance of Thresher

The experimental data revealed that the grain output of the jowar crop with rasp bar type of cylinder increased from 75.311 to 78.3014 kg/h with increases speed from 300 to 500 rpm. The maximum output was at 500 rpm. The percentage increase in output was about 2.90 when cylinder speed increased from 300 to 400 rpm but it was about 1.03 per cent for the speed increase from 400 to 500 rpm.

The threshing efficiency of the thresher was ranged from 87.21 to 89.13 per cent and increased as cylinder speed increased. The maximum threshing efficiency was at the cylinder speed of 500 rpm. This may be because of higher shearing action of the rasp bars with ear heads.

The data of grain damage of the jowar crop with rasp bar type of cylinder increased from 1.90 to 2.13 per cent with increases speed from 300 to 500 rpm. The maximum grain damage was at 500 rpm. The per cent increase in grain damage was about 4.73 when cylinder speed increased from 300 to 400 rpm but it was about 7.04 per cent for the speed increase from 400 to 500 rpm. It indicated that as speed increased grain damage was increased. The overall value of the grain damage was in an expectable range.

The cleaning efficiency of the thresher with jowar crop with rasp bar type cylinder increased from 86.34 to 87.14 per cent with increases speed from 300 to 500 rpm. The maximum cleaning efficiency was observed 500 rpm. This may be because of the higher blower speed.

Table 3: Performance of Thresher with Peg Tooth Type Cylinder for Jowar Crop

Treatment	Grain output (kg/h)	Threshing Efficiency %	Grain Damage %	Cleaning Efficiency %
$T_1C_2S_1$	76.412	88.92	2.42	81.08
$T_1C_2S_2$	78.413	89.01	2.76	82.41
$T_1C_2S_3$	79.816	89.78	2.83	83.01

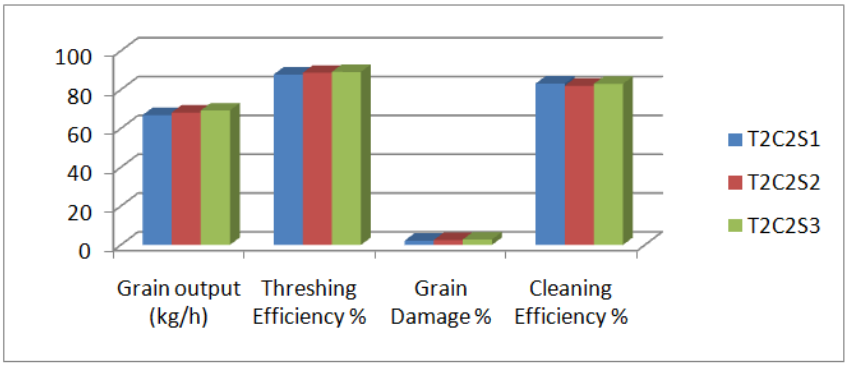

Figure 2: Performance of Thresher

As shown in Table 2, the grain output of the jowar crop with peg tooth type of cylinder increased from 76.412 to 79.816 kg/h with increase speed from 300 to 500 rpm. The maximum output was at 500 rpm. The per cent increase in output was about 2.001 when cylinder speed increased from 300 to 400 rpm but it was about 1.789 per cent for the speed increase from 400 to 500 rpm.

The threshing efficiency of the thresher was increased from 88.92 to 89.78 per cent with cylinder speed increased. The maximum threshing efficiency can obtained at the cylinder speed of 500 rpm.

The records of grain damage of the jowar crop increased from 2.42 to 2.83 per cent with increased speed from 300 to 500 rpm. The maximum grain damage was at 500 rpm. The per cent increase in grain damage was about 14.05 when cylinder speed increased from 300 to 400 rpm but it was about 2.536 per cent for the speed increase from 400 to 500 rpm it shown that as speed increased grain damage was decreased.

The cleaning efficiency of the thresher with jowar crop with peg tooth type of cylinder increased from 81.08 to 83.01 per cent with increase speed from 300 to 500 rpm. The maximum cleaning efficiency was observed 500 rpm. This may be because of higher blower speed.

Table 4: Performance of Thresher with Rasp Bar type Cylinder for Bajra Crop

Treatment	Grain output (kg/h)	Threshing Efficiency %	Grain Damage %	Cleaning Efficiency %
$T_2C_1S_1$	66.313	87.12	2.14	82.37
$T_2C_1S_2$	67.659	88.33	2.32	83.22
$T_2C_1S_3$	68.162	88.47	2.71	84.01

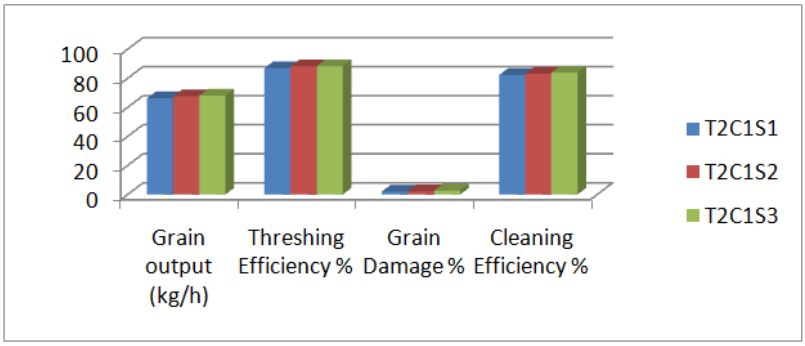

Figure 3: Performance of Thresher

The observations data shown that the grain out of the bajra crop with rasp bar type of cylinder increased from 66.313 to 68.162 kg/h with increases speed from 300 to 500 rpm. The per cent increase in output was about 2.03 when the cylinder speed increased from 300 to 400 rpm but it was about 0.743 per cent for the speed increase from 400 to 500 rpm.

The threshing efficiency of thresher was from 87.12 to 88.47 per cent and increased was cylinder speed increased. The threshing efficiency was maximum at the cylinder speed of 500 rpm. The may be the reason for higher shearing action of the rasp bar with ear heads.

The experimental data of grain damage of the bajra crop with rasp bar type of cylinder increased from 2.14 to 2.71 per cent with increases speed rom 300 to 500 rpm. The maximum grain damage was at 500 rpm. The per cent increase in grain damage was about 8.411 when cylinder speed increased from 300 to 400 rpm but it was about 16.81 per cent for the speed increases from 400 to 500 rpm. It indicates that as the speed increased grain damage was increased. The overall value of the grain damage was in an expectable range.

The cleaning efficiency of the thresher with bajra crop with rasp bar type of cylinder increased from 82.37 to 84.01 per cent with increases speed from 300 to 500 rpm. The maximum cleaning efficiency was observed 500 rpm. This may be because of higher blower speed.

Table 5: Performance of Thresher with Peg Tooth Type Cylinder for Bajra Crop

Treatment	Grain Output (kg/h)	Threshing Efficiency %	Grain Damage %	Cleaning Efficiency %
$T_2C_2S_1$	66.922	87.82	2.21	83.17
$T_2C_2S_2$	68.219	88.71	2.50	82.05
$T_2C_2S_3$	69.323	89.17	2.80	83.01

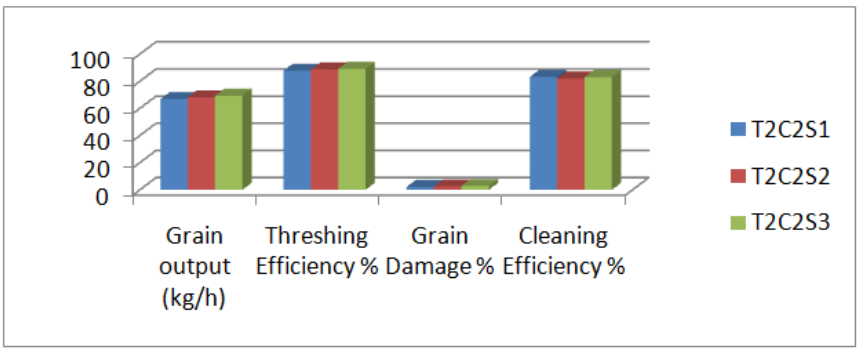

Figure 4: Performance of Thresher

The data revealed that the grain output of the bajra crop with peg tooth type of cylinder increased from 66.922 to 69.323 kg/h with increase speed from 300 to 500 rpm. The maximum output was at 500 rpm. The per cent increase in output was about 1.938 when cylinder speed increased from 300 to 400 rpm but it was about 1.618 per cent for the speed increase from 400 to 500 rpm. The threshing efficiency of the thresher was ranged from 87.82 to 89.17 per cent and increased as cylinder speed increased. The threshing efficiency was maximum at the cylinder speed of 500 rpm. This may be because of higher shearing action of the peg tooth. The data of grain damage of the bajra crop with peg tooth type of cylinder increased from 2.21 to 2.80 per cent with increased speed from 300 to 500 rpm. The maximum grain damage was at 500 rpm. The per cent increase in grain damage was about 13.122 when cylinder speed increased from 300 to 400 rpm but it was about 12 per cent for the speed increase from 400 to 500 rpm. It indicated that as speed increase grain damage was decreased. The overall value of the gain damage was in an expectable range. The cleaning efficiency of the thresher with bajra crop with peg tooth type of cylinder increased from 83.17 to 83.01 per cent with increase speed from 300 to 500 rpm. This may be because of higher blower speed.

CONCLUSIONS

At very high speed and low speed of the cylinder the threshing efficiency decreases, but at the maximum speed at 500 rpm the thresher providing a maximum efficiency of the crops. There for the selection of motor with required speed and deciding of spacing between concave and cylinder and feeding rate is important role the get the maximum efficiency. This thresher easy to handle, maintain, convey form one place to other and require minimum labour handle. The thresher threshes, cleans and grades the crops.

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